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Citation for published version:

Akhurst, MC, McDermott, C, Williams, J, Mackay, EJ, Jin, M, Tucker, O, Mallows, T, Hannis, S & Pearce, J 2016, 'Optimising geological storage of CO₂ by development of multiple injection sites in regionally extensive storage sandstones', Paper presented at 13th European Geosciences Union General Assembly 2016, Vienna, Austria, 17/04/16 - 22/04/16.

Link:

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Document Version:

Publisher's PDF, also known as Version of record

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Optimising geological storage of CO₂ by development of multiple injection sites in regionally extensive storage sandstones

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Carbon capture, transport and storage (CCS) is considered a key technology to provide secure, low-carbon energy supply and industrial processes to reduce the greenhouse gas emissions that contribute to the adverse effects of climatic change. Geological storage of carbon dioxide (CO₂), captured during hydrocarbon production at the Sleipner Field, in strata beneath the Norwegian sector of the North Sea has been in operation since 1996. Projects to store CO₂ captured at power plants in strata underlying the North Sea are currently in design. Storage of the CO₂ is planned in depleted hydrocarbon fields or regionally extensive sandstones containing brine (saline aquifer sandstones).

The vast majority of the UK potential storage resource is within brine-saturated sandstone formations. The sandstone formations are each hundreds to thousands of square kilometres in extent and underlie all sectors of the North Sea. The immense potential to store CO₂ in these rocks can only be fully achieved by the operation of more than one injection site within each formation. Here we report an investigation into the operation of more than one injection site within a storage formation using a UK North Sea case study of the Captain Sandstone and the included Goldeneye Field, which is part of the mature hydrocarbon province offshore Scotland.

Research by the CO₂MultiStore project was targeted to increase understanding and confidence in the operation of two sites within the Captain Sandstone. Methods were implemented to reduce the effort and resources needed to characterise the sandstone, and increase understanding of its stability and performance during operation of more than one injection site. Generic learning was captured throughout the research relevant to the characterisation of extensive storage sandstones, management of the planned injection operations and monitoring of CO₂ injection at two (or more) sites within any connected sandstone formation.

The storage of CO₂ can be optimised by the operation of more than one injection site in a geological formation by taking a regional-scale approach to site assessment. The study concludes that at least 360 million tonnes of CO₂ captured over the coming 35 years could be permanently stored using two injection sites in the Captain Sandstone. Confidence in the planned operation of two or more injection sites in a storage formation is greatly increased by the use of existing information, knowledge and data acquired during hydrocarbon exploitation. Widespread pressure changes should be expected by the injection of CO₂ at more than one site. Assessment, management and monitoring of pressure changes on a regional scale will optimise the storage capacity, ensure security of storage and prevent adverse effects to existing storage and hydrocarbon operations.

The vast offshore potential across all sectors of the North Sea could be made accessible and practical for storage of CO₂ captured at European sources by the operation of two or more sites in a storage formation by following the approach taken in CO₂MultiStore.